8th. World Congress on Computational Mechanics (WCCM8)
5th. European Congress on Computational Methods in Applied Sciences and Engineering (ECCOMAS 2008)
June 30 – July 5, 2008
Venice, Italy

PLASTIFICATION OF R/C FRAMES UNDER MONOTONIC LOADING

***B. Trogrlić[1], A. Mihanović[2] and I. Balić[3]**

University of Split, Faculty of Civil Engineering and Architecture
Matice hrvatske 15, 21000 Split, CROATIA
boris.trogrlic@gradst.hr, ante.mihanovic@gradst.hr, ivan.balic@gradst.hr

Key Words: *R/C frame, plastic hinge, monotonic loading, failure mechanism*

ABSTRACT

In this paper the plastification of the reinforced concrete (R/C) frames are analyzed by numerical model [1, 2] which includes material and geometric nonlinearity according to small displacement theory. The global iterative-incremental procedure is used with a monotonic increase of loading until collapse of system which caused by occurring of mechanism and/or losing of stability. The composite cross sections are described by numerical model. For analysis of space frames, the torsional effect and consequently the effect of the shear force of the reinforced concrete element are observed on the so-called comparative body. It is formed so that the square elements from the cross-section discretization are extended along the whole linear finite element and form an elastic body discretized by 3D brick finite elements (Figure 1b). The essential properties of results with plastification of R/C frames are changes of position of plastic hinges. After the first appearance, during increment procedure, plastic hinge can disappear and appear again. The complete process of plastic hinge appearance is non-continuous. The dominant order of the plastic hinge appearance i.e. the dominant failure mechanism is only what can be determined.

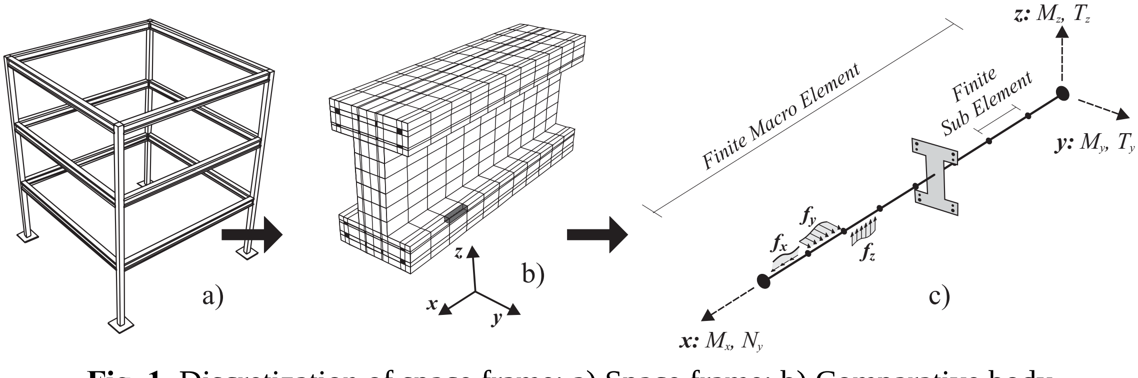

Fig. 1. Discretization of space frame: a) Space frame; b) Comparative body discretization; c) Beam-column element discretization

Two examples of planar R/C frames are analyzed. Basic geometric properties, material properties and loading (same for both of examples) are presented on Figures 2a and 2c. In the first example, cross sections are named 'beam' and 'column1' (Figure 2b), whereas for the second example cross sections are named 'beam' and 'column2' (Figure

2b). Numerical results of the first example are presented of Figure 3. Plastic hinge position and ordinal are presented on Figure 3a. Equilibrium path of the top of frame is presented by Figure 3b. The ratio between load intensity at the failure of model and load intensity at the first plastic hinge appearance is $\alpha_u/\alpha_1 = 1.66$.

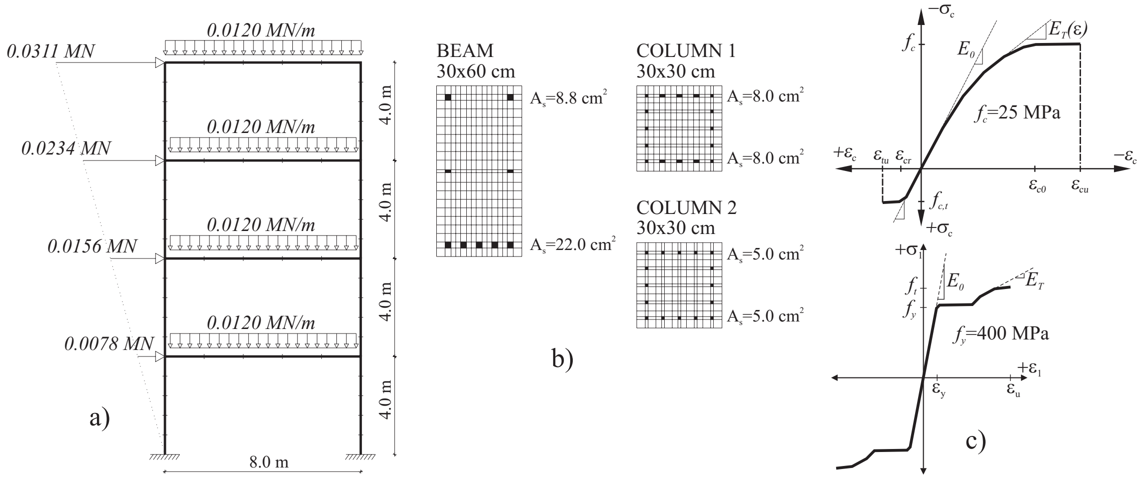

Fig. 2. Frame1: a) Load; b) Section discretization; c) Numerical model of materials

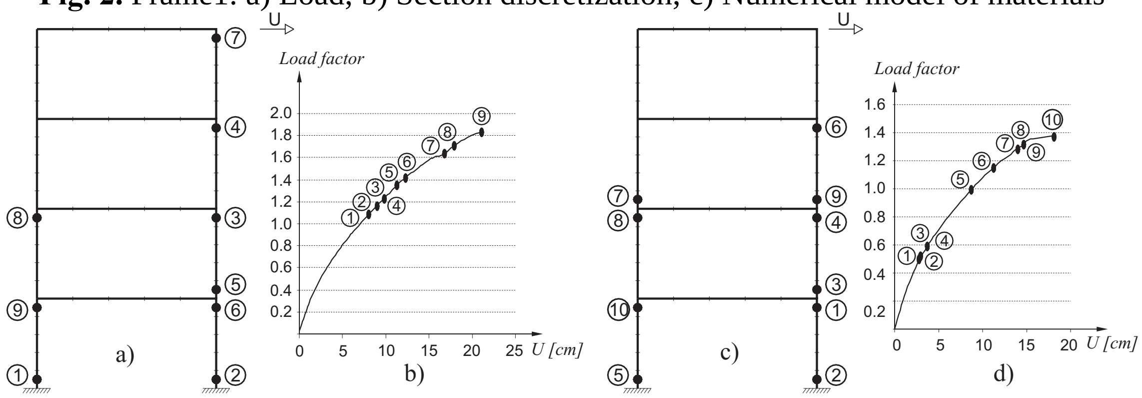

Fig. 3. Frames: a) Plastic hinges on Frame1; b) Equilibrium path for Frame1; c) Plastic hinges on Frame2; d) Equilibrium path for Frame2

Relevant results for the second example are presented on Figures 3c and 3d. In this case, the ratio between load intensity at the failure of model and load intensity at the first plastic hinge appearance is $\alpha_u/\alpha_1 = 2.93$.

In conclusion the following remarks can be made: (i) used model is acceptable for nonlinear analysis of frames, (ii) practical examples shows that quite small differences in reinforcing of R/C columns have significant influence on load intensity at the appearance of the first plastic hinge, (iii) a quite small differences in reinforcing of R/C columns have significant influence of plastic capacity of system, (iv) finally, the total load intensity at failure of frames is in compliance with area of reinforcing.

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